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ABSTRACT

This report presents results of a concurrent validation study for the Chicago District Council of Carpenters Apprentice and Trainee Program. Its purpose was to develop a fair screening device for applicant selection. Advanced apprentice carpenters in three specialities--construction, cabinet making, and floor covering--were administered the Ball Aptitude Battery (BAB) in the fall of 1980. Performance measures (overall grade point average (GPA) and instructor's rating) were also collected. Useable data were collected on 184 individuals. Eight of the 14 tests in the BAB correlated significantly with both GPA and instructor's rating. Multiple regression analysis results showed that four of the tests--Vocabulary, Paper Folding, Numerical Computation (Numerical Ability-I), and Numerical Reasoning (Numerical Ability-II)--significantly correlated with apprenticeship performance, as measured by GPA and instructor ratings. Validity coefficients were almost equal for both majority and minority ethnic groups using a composite score of these four tests as a predictor and GPA as a criterion. It is recommended that the four BAB tests be used to assist in the selection of applicants to the Apprentice Carpenter and Trainee Program. Appendices contain: (1) course skills and related test aptitude factors; (2) specialty job descriptions; (3) intercorrelation statistics, and (4) regression lines. (Author/BS)

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Technical Report No. 10

DEVELOPMENT AND VALIDATION OF A SELECTION PROCEDURE FOR AN APPRENTICE CARPENTER AND TRAINEE PROGRAM

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May, 1983

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Executive Summary

This report presents the results of research which investigated the concurrent (or present employee) validity of selected aptitude tests for the Chicago District Council of Carpenters Apprentice and Trainee Program. That is, this research investigated the relationship between performance on aptitude tests and performance in apprenticeship training.

The purpose of this research was to develop a valid and fair test battery to assist in the selection applicants to the Apprentice Carpenter and Trainee Program.

Advanced apprentice carpenters in three specialities--construction, cabinet making, and floor covering--were administered the Ball Aptitude Battery (BAB) in the fall of 1980. At approximately the same time measures of performance--overall grade point average (GPA) and instructor's rating--were collected on the apprentices. Usable data were collected on 184 individuals.

Eight of the 14 tests in the BAB correlated significantly with both GPA and instructor's rating. By using a standard statistical procedure (multiple regression analysis), it was found that four of the tests--Vocabulary, Paper Folding, Numerical Computation (Numerical Ability-I), and Numerical Reasoning (Numerical Ability-II)--significantly correlated with apprenticeship performance, as measured by

GPA and instructor's rating. The strength of the relationship between the tests and measures of performance is indexed by a multiple correlation coefficient. A multiple correlation coefficient of 0 (zero) means there is no relationship. A coefficient of 1 (one) means a perfect relationship. The multiple correlation coefficient using these four tests was .48 (with GPA as the criterion). A multiple correlation coefficient of .48 is considered more than adequate by industrial psychologists.

Validity coefficients were almost equal for both majority and minority ethnic groups using a composite score of these four tests as a predictor and GPA as a criterion.

It is recommended that the four BAB tests be used to assist in the selection of applicants to the Apprentice Carpenter and Trainee Program.

Acknowledgements

Grateful acknowledgement is due to the Chicago District Council of Carpenters for sponsoring this project. Thanks are due to Mr. Cliff LaMaster and Mr. "Duffy" Dardar for their support and advice throughout the project. Acknowledgement is due to the many instructors of the School of Carpentry of the Washburne Trade School who generously gave of their time. Mary Spatz and Cindy Fritz did an outstanding job in administering the tests and preparing the data. Ms. Elizabeth Rengel assisted with data analysis and interpretations. Mrs. Addi Hills and her staff at Geo. J. Ball, Inc. typed the manuscript and did a superb job despite tight deadlines.

CHAPTER I

Introduction

This report presents the results of a criterion-related validation study for the Chicago District Council of Carpenters Apprentice and Trainee Program. The purpose of this research was to develop a fair screening device designed to tap important aptitudes required for the successful completion of training in carpentry.

Background and Feasibility

Since 1965 several commercially available tests were being used in selecting applicants to the program: the Primary Mental Abilities Test (Thurstone, 1965) and five of Flanagan's (1975) Industrial Tests: Assembly, Judgment and Comprehension, Components, Patterns, and Arithmetic. The tests were administered and scored by a consulting firm, and were apparently not selected on the basis of a systematic job analysis. In 1973 the consulting firm conducted a validation study of the tests using 1,171 individuals who had been tested and who participated in the Apprentice Carpenter and Trainee Program since 1965 (Hodgson, 1978). While several of the tests had positive and significant correlations with various criteria of training success for the total group, none of the tests had significant positive correla-

tions with Apprentice Training GPA for the minority group (Hodgson, 1978, p. 25). Similarly, none of the cross-validation sample Rs for the minority sample was significant on any of the training criteria examined (Hodgson, 1978, p. 34). No mention was made of how cutting scores might affect minority-majority differences on adverse impact. The Rs for the total and majority cross-validation samples, using GPA as the criterion, were .26 and .17, respectively.

These results indicated the need for another test battery. Specifically a test battery was needed which was validated according to Uniform Guidelines on Employee Selection Procedures (Equal Employment Opportunity Commission or EEOC, Civil Service Commission, Department of Labor, and Department of Justice, 1978), which would have greater predictive power, and would be valid for both majority and minority applicants.

During the fall and winter of 1977-1978 the Ball Foundation, as part of a larger study, examined the relationship between scores on the Ball Aptitude Battery (BAB) and success in carpentry training. With the cooperation of Washburne Trade School, the Foundation tested 194 pre-apprentices and apprentices enrolled in construction carpentry. The results indicated that selected BAB tests had significant correlations with success in the training program (Sung, 1979). After discussions with officials of the Chicago District Council of Carpenters and the Carpentry School

of the Washburne Trade School, it was suggested that the BAB might be useful for screening and classifying applicants to the Apprentice and Trainee Program.

Experiences from and results of the initial study (Sung, 1979) indicated that a concurrent validation study would be feasible in terms of: adequacy of sample size, criterion measures, and range and accuracy of predictor scores. In the summer of 1980, the Ball Foundation was awarded a research grant by the Chicago District Council of Carpenters Apprentice and Trainee Program. The goal of the research was to develop an improved apprentice selection procedure. Specifically, the procedure was needed which: (1) would assist school officials in selecting qualified applicants, and (2) which was in compliance with the Uniform Guidelines on Employee Selection Procedures adopted by the EEOC et al. (1978), thereby meeting the standards of the Bureau of Apprenticeship Training of the Department of Labor.

Specialities within the training program to be considered were: construction, mill cabinet making, and floor covering.

Assessing Occupational Aptitude

Aptitude tests are designed to explore the limits of human response capability on selected tasks (Cronbach,

1960). These tasks have been selected because the responses they draw out of people are components of human skills. Therefore, in principle, the potential of any individual for any skill can be estimated from a knowledge of (a) the ability components of the skill, and (b) the standing of the individual on each of these ability components. It is in this manner that aptitude -- human potential for a skill -- is estimated through an aptitude test battery such as the BAB (Sung & Dawis, 1981).

What has been said about skills can be said about jobs and occupations, for jobs and occupations require sets of skills. Therefore, one can speak about aptitude for a job or aptitude for an occupation by referring to some cumulative sum, or average, of aptitudes for the skills required by the job or occupation.

Well-validated aptitude tests have consistently been found to be good predictors of job and occupational proficiency (Ghiselli, 1955, 1966; Guion, 1965, 1976; Wigdor & Wendell, 1982). Aptitude tests are especially useful for making decisions about applicants just entering the work force. Since these individuals have little relevant experience, it is best to make selection decisions on a measure of <u>potential</u> to succeed in training on a job (Wigdor & Wendell, 1982). Appropriate aptitude tests have demonstrated strong and significant validities with success in carpenter training programs (Ghiselli, 1955; U.S. Department of Labor, 1970).

Alternative Procedures

Several procedures other than aptitude tests are available for predicting training or job success. However very few studies are available which investigated the effectiveness of these procedures for specifically predicting success in carpentry training and apprentice programs. Therefore, we will examine the general effectiveness of alternative procedures compared to aptitude tests.

Interviews. Reviews of the literature on the employment interview have been consistent in noting that the reliability and validity of traditional selection interviews are deficient (Mayfield, 1964; Ulrich & Trumbo, 1965; Wagner, 1949). Newer techniques may improve the reliability and validity of the employment interview to where it is comparable with a well developed aptitude test (Jantz, 1982; Latham, Saari, Purcell, & Campion, 1980), but more research is needed. Also, as Arvey (1979) points out, there are several processes inherent in the interview which can contribute to bias (stereotyping and different behavior of applicants).

Assessment Centers. Assessment centers typically involve prediction via behavioral exercises, multiple raters, and multiple personality and ability tests. While

assessment centers are usually quite valid (Finkle, 1976), they can be more costly and time consuming than paper-and-pencil aptitude tests (Cascio & Silbey, 1979), and some have suggested that they are not appreciably more valid than good paper-and-pencil measures (Hinrichs, 1978). Also, most of the validity studies done with assessment centers have been concerned with one occupation: management.

Biographical Questionnaires. Biographical questionnaires have been found to have consistently high predictive validities (Owens, 1976). However, there is no solid evidence of the job relatedness of biographical questionnaires (Wigdor & Wendell, 1982). They can also be unfair towards various ethnic minorities and women (Wigdor & Wendell, 1982).

Work Samples. Work samples have often been found to be strong and fair predictors (Cascio & Phillips, 1979). However, they do not measure cognitive abilities which are related to important aspects of many jobs (such as problem solving, reading instructions, etc.). Also, differences in test impact appear to be due to test range rather than difference in type of test (Ironson, Guion, & Ostrander, 1982).

Trial Employment Period. An alternative to employment testing is a trial employment period: allow the individual

the opportunity to learn the skill and to find out from this experience whether the aptitude is there or not. Only by trying to learn a skill can a person find out how well he or she can learn and perform the skill. However, no person has either the time or the resources to attempt learning more than a limited number of skills. Similarly, organizations do not have the resources to allow all applicants the opportunity to attempt to learn the skills for the positions they are considering. It is quite useful, to both individuals and organizations, to have a way of ascertaining beforehand whether one has the aptitude for a skill before investing time and resources into learning the skill.

Aptitude Tests. From the above review, it is clear that alternative selection methods will not demonstrate appreciably stronger validity or less adverse impact than a valid aptitude test. We agree with the Committee on Ability Testing of the National Research Council (Wigdor & Wendell, 1982):

> The committee has seen no evidence of alternatives to testing that are equally informative, equally adequate technically, and also economically and politically viable. (p. 144)

Overview

This report is organized to reflect the order in which each phase of the project was carried out. Chapter II describes the research sample, an analysis of the training program, the selection of the occupational aptitude battery tests, selection of criteria, and the research procedure. Chapter III presents the major results of the study: descriptive statistics on group differences in predictor and criterion variables, zero-order correlations between predictor and criterion variables, and the regression analyses used in selecting the final set of tests and in developing a prediction equation. In Chapter IV, issues related to differential validity and adverse impact are discussed, as are conclusions and recommendations.

CHAPTER II

Methodology

A standard method of performing validation studies was adopted for this project. For a more general discussion of the methodology consult Science Research Associates (1973) or Guion (1965); a more detailed description of the statistical elements may be obtained by consulting Tatsuoka (1976).

Sample

Subjects in this study consisted of carpentry students at the Washburne Trade School who were specializing in construction, cabinet making, and floor covering. An effort was made to include apprentices who were most advanced in training to control the amount of training experience and to obtain as many reliable criteria as possible. The initial sample consisted of 325 subjects. The sample ranged in age from 18 to 32 years, with a mean age of 22.6 and a standard deviation of 3.2. The number of years of education completed ranged from 9 to 19, with a mean of 12.6 years. The breakdowns of age, education and high school grade point average by construction specialty and ethnic groups are given in Tables 1 and 2.

TABLE 1

Means of Demographic Variables
by Specialty Group

Demographic Variable	Specialty Group					
	Construction		Cabinet		Floor	
	M	Sd	M	Sd	M	Sd
Age	22.6	3.2	23	3	21.7	3.4
Education	12.6	1.1	13.1	1.8	12.4	1.5
High School GPA	2.4	.7	2.6	.6	2.3	.6

TABLE 2

Means of Demographic Variables
by Ethnic Group

Demographic Variable	Ethnic Group			
	Majority		Minority	
	M	Sd	M	Sd
Age	22.4	3.2	23.5	3.3
Education	12.6	1.3	12.6	1.1
High School GPA	2.4	.7	2.4	.6

Because of missing data, 141 individuals from the construction sample (122 majority and 19 minority) were omitted. Thus, the final sample on which the major analyses were based consisted of 184 individuals. These included 103 trainees in construction, 48 in mill cabinet making, and 33 in floor covering installation. Twenty-seven individuals were minority group members.[1] A breakdown of the number of subjects by ethnic and specialty groups is given in Table 3. Nearly 56 percent of the total sample is in the construction specialty.

Program Analysis

The Apprentice Training program is four years in length, although the curricula differ by speciality. The construction and floor covering specialities have pre-apprentice training which consists of full time course work for twelve weeks. The next two and three quarter years for the construction and floor covering students consist of on the job training and attending classes one day every other

---

[1] Throughout this report the term minority will be used to refer to non-Caucasian apprentices. Approximately 70 percent of the apprentices in the minority sample are Blacks, while the remaining 30 percent are either Hispanics or other ethnic subgroups.

TABLE 3

Distribution of Final Sample by Specialty and Ethnic Groups

	Ethnic Group		
Speciality	Majority	Minority	Total
Construction	92	11	103
Cabinet Making	39	9	48
Floor Covering	26	7	33
Total	157	27	184

week. The final year consists solely of on the job training. The cabinet making students have no pre-apprentice training. Their first three years involve on the job training and classes one day every other week. Their last year is solely on the job training. Course titles for the three specialities are listed in Appendix 1. All students are graded every quarter by their course instructors for the first three years. They receive one grade during their fourth year, which is given by the job contractor.

Complete job descriptions of the three specialities from the Dictionary of Occupational Titles (1977) are given in Appendix 2.

The program content was thoroughly analyzed to determine task and skill requirements which are important in identifying respective aptitude components. Descriptions of the nature of the work for each carpenter specialty and of the curricular content for each course were obtained from the school. Reference materials used in the courses were also obtained. In addition, instructors in the three areas of specialties were interviewed regarding course content. These data were then studied and analyzed to identify the skills involved in each course. As an example, Table 4 presents the skills identified for a pre-apprentice shop course and a blue print reading course. Aptitudes for skill components for each course were estimated (see Appendix 1) by two Ball Foundation researchers.

TABLE 4

Skills Identified
For Two Courses

Shop	Blue Print Reading
Differentiate various hand and power tools	Identify various parts of building and shape of building
Use tools to cut, scrub, grind and drill, etc.	Interpret blue prints
Maintain tools (sharpening, lubricating)	Differentiate types of materials and estimate volumes of materials
Sketching	

Selection of Aptitude Tests (Predictors)

Tests from the Ball Aptitude Battery (Sung & Dawis, 1981a) were selected for the present study for three rea-reasons. First, most of the aptitude factors which were related to the course skills are included in the BAB. Second, the BAB could be administered to subjects within practical time limits. And third, the psychometric properties of the instrument are sound and well documented. The BAB not only demonstrates acceptable reliability and validity (Sung & Dawis, 1981a), it also demonstrates factorial independence and has been shown to exhibit similar factor structures between race and sex groups (Sung & Dawis, 1981b).

Twelve tests were selected from the BAB for the study of three specialties of carpentry:

1. Clerical Ability: Measures the ability to perceive visual details, similarities and differences.
2. Idea Fluency: Measures the ability to produce ideas of alternative uses for a given object.
3. Inductive Reasoning: Measures the ability to identify a rule: to reason from specific information to a general principle.
4. Paper Folding: Measures the ability to visualize in three-dimensional space using a two-dimensional test.

5. Vocabulary: Measures the ability to choose the right word that represents an idea.
6. Ideaphoria: Measures the ability to generate a rapid and abundant flow of words and ideas.
7. Finger Dexterity: Measures the ability to use the hands to make skillful, controlled manipulations of small objects, principally involving finger movement.
8. Grip: Measures the strength of grip of both left and right hands.
9. Shape Assembly: Measures the ability to visualize in three-dimensional space.
10. Analytical Reasoning: Measures the ability to reason from a general principle to specific information and from specific examples to a general principle: the ability to organize related concepts in a systematic manner.
11. Numerical Computation (Numerical Ability-I): Measures the ability to perform basic arithmetic computation, with speed and accuracy.
12. Numerical Reasoning (Numerical Ability-II): Measures the ability to reason logically.

Criteria

Number of training hours required, number of hours worked, and course grades for each course were obtained as

validation criteria. The first criterion is assumed to reflect rate of learning, the second represented successful on-the-job performance (acceptance by employers), and the third was teacher evaluation. Study of these criteria showed that course grades were the only ones that were satisfactory. Further study of the distribution characteristics of course grades led to the decision to use composite grades (averages) as the criterion and to refine the grade scale as follows:

A+ = 12, A = 11, A- = 10, B+ = 9, B = 8, B- = 7, C+ = 6, C = 5, C- = 4, D+ = 3, D = 2, and D- = 1.

To provide a second criterion of overall performance, Washburne instructors were asked to rate their classes in the following manner. First, they identified the most important requirements for the program. Keeping these requirements in mind, they divided their class into two equal halves, an upper and a lower half. They took each half and sub-divided it further into two, thereby dividing the class into four equal parts. The top quarter of trainees were then rated 4, the next, 3, the next after that, 2, and the bottom quarter, 1.

Procedure

Data for this project were collected by members of the Ball Foundation staff, with the cooperation and assitance of

the Washburne Trade School administration, staff and faculty. Predictor and criterion data were collected at the Washburne School from September to December, 1980.

BAB tests were administered to the trainees in small groups and individually as required by BAB test administration procedures. Before each administration, Ball Foundation test administrators outlined the purpose of the study and the nature of the trainees' participation, emphasizing that test materials and individual results would be handled on a confidential basis.

Data on the first criterion, course grades, were obtained from school records. Ratings, as explained above, were obtained from the instructors.

CHAPTER III

Results

This chapter describes three sets of results. The first focuses on descriptive statistics -- means and standard deviations on predictor and criterion variables by speciality and ethnic groups. The second section presents the zero-order correlations between predictor and criterion variables. The third section describes regression analyses and the development of a prediction equation.

Descriptive Statistics

Table 5 presents the means (Ms) and standard deviations (Sds) of the BAB tests (predictors) by carpentry specialities; Table 6 presents the means and standard deviations of the criterion measures by the three specialities. Each table also shows the results of t-tests (Weinberg & Goldberg, 1979) which were performed to test for significant differences between speciality and total group scores. On all measures except Ideaphoria, Numerical Computation and Numerical Reasoning, no significant differences were found between the mean predictor scores for the three samples and the total group. On the Numerical Computation, mean score difference was significant at the .01 level. On the other two tests, Numerical Reasoning and Ideaphoria, the mean dif-

TABLE 5

Means and Standard Deviations of BAB Scores by Carpentry Speciality

Test	Construction		Cabinet Making		Floor Covering		Total	
	M	Sd	M	Sd	M	Sd	M	Sd
Clerical	184.58	19.50	183.52	18.65	182.82	21.60	183.98	19.58
Idea Fluency	25.18	9.20	24.96	8.72	23.54	8.43	24.82	8.92
Inductive Reasoning	22.80	3.18	22.62	3.06	22.78	2.84	22.76	3.07
Paper Folding	12.18	4.16	13.12	4.12	10.72	4.22	12.16	4.21
Vocabulary	40.52	15.88	42.27	19.66	36.58	15.67	40.26	16.92
Ideaphoria	116.08	57.74	106.42	51.77	91.54*	61.96	109.16	57.48
FD - Left	40.18	5.13	37.60	5.10	38.77	5.58	39.28	5.29
FD - Right	43.60	5.68	39.85	6.52	41.68	5.24	42.28	6.03
Grip - Left	171.58	22.64	167.91	30.64	173.12	27.75	170.88	25.74
Grip - Right	184.25	24.64	182.34	30.13	184.70	27.27	183.83	26.48
Shape Assembly	20.50	5.96	21.91	5.46	18.68	6.20	20.54	5.94
Analytical Reasoning	29.76	14.28	29.36	12.36	31.06	14.50	29.88	13.78
Numerical Computation	11.52	5.26	11.46	5.26	5.44**	4.06	10.42	5.55
Numerical Reasoning	11.29	5.18	13.06*	4.87	9.00*	5.24	11.32	5.26

NOTE: Significance tests (t-tests) are between speciality groups and total group.

* $p < .05$
** $p < .01$

TABLE 6

Means and Standard Deviations of Criterion Scores by Carpentry Speciality

	Construction		Cabinet Making		Floor Covering		Total	
Criteria	M	Sd	M	Sd	M	Sd	M	Sd
Grade Point Average	7.72	1.24	6.60**	1.60	7.38	1.70	7.36	1.50
Instructor's Rating	2.68	1.95	2.48	1.11	2.84	1.42	2.66	1.19

NOTE: Significance tests (t-tests) are between speciality groups and total group.

** $p < .01$

ferences were significant at the .05 level. The scores of floor covering sample tend to be lower on most tests than scores of the other two samples.

As shown in Table 6, the mean grade point averages of the construction and floor covering groups were higher than the GPAs of the cabinet making group. The GPA of the cabinet making group was significantly lower than the GPA for the total sample.

Table 7 presents the means and standard deviations of the BAB tests by ethnic group; Table 8 presents the means and standard deviations of the criterion measures by ethnic group; t-tests were conducted to determine if group scores differed significantly from each other.

In comparing the mean scores of minority and majority samples on aptitude and criterion measures, the mean scores for the majority sample were higher than the minority sample on most of the tests except Finger Dexterity-Left, Finger Dexterity-Right, and Grip-Right. However, only five of these differences were statistically significant. On Inductive Reasoning, Numerical Computation, and Numerical Reasoning the mean differences were significant at .05 level; on Idea Fluency and Vocabulary the mean score differences were significant at the .01 level. The actual mean differences found in the present study are not particulary large (all are smaller than one standard deviation), and are smaller than differences found in other studies with the BAB (Sung &

TABLE 7

Means and Standard Deviations of
BAB Scores by Ethnic Group

	Majority		Minority		
Test	M	Sd	M	Sd	Difference
Clerical	183.39	24.02	180.62	22.54	2.77
Idea Fluency	25.29	9.18	20.22	8.43	5.07**
Inductive Reasoning	22.96	3.05	21.55	2.92	1.41*
Paper Folding	12.33	4.29	11.22	3.63	1.11
Vocabulary	41.78	17.05	29.96	14.08	11.82***
Ideaphoria	111.62	57.91	94.81	53.62	16.81
FD - Left	37.94	9.14	38.33	5.80	-.039
FD - Right	40.98	9.54	42.04	5.94	-1.06
Grip - Left	167.52	36.63	165.14	30.04	2.38
Grip - Right	179.42	39.08	182.22	27.25	-2.80
Shape Assembly	20.24	6.82	18.51	6.22	1.73
Analytical Reasoning	29.84	14.54	25.70	12.62	4.14
Numerical Computation	10.63	5.64	7.59	5.61	3.04*
Numerical Reasoning	11.48	5.26	8.66	6.11	2.82*

NOTE: Majority N = 157; Minority N = 27; FD = Finger Dexterity.

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 8

Means and Standard Deviations of
Criterion Scores by Ethnic Group

	Majority		Minority		
Criteria	M	Sd	M	Sd	Difference
Grade Point Average	7.60	1.40	5.96	1.32	1.64**
Instructor's Rating	2.82	1.12	1.66	1.16	1.16**

NOTE: Majority N = 157; Minority N = 27.

** $p < .001$

Dawis, 1981b). The largest difference was on the Vocabulary test. Difference scores for the present sample in standard units are presented in Figure 1.

The mean score differences between the majority and minority groups on both criterion measures were significant at the .01 level.

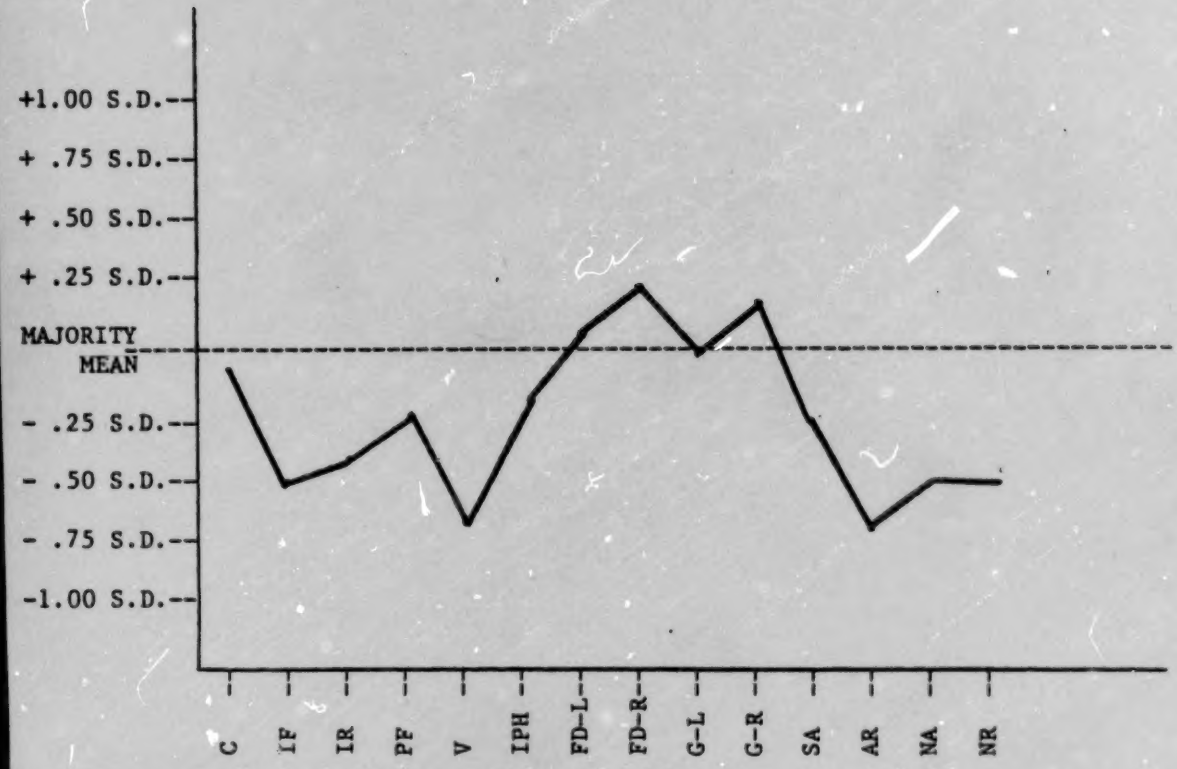
Correlational Analyses

This section deals with the validity of the aptitude tests, that is, the degree of their relationship with training performance. Results are presented which examine the validity of the tests with regard to the total sample, the three carpentry specialities, and the two ethnic groups. These relationships are examined in relation to the two criteria of grade point average and instructor's rating on overall performance.

Table 9 presents the validity (or Pearson product moment correlation) coefficients for the total sample. The pattern of correlations across tests is similar for the two criteria, although the correlations, in general, are slightly higher for GPA than instructor's rating. Significant and relatively strong validities are found with tests relating to Inductive and Analytical Reasoning, Spacial Ability (Paper Folding and Shape Assembly), Numerical Computation and Reasoning, and Vocabulary. Although significant in a

Figure 1

Differences Between Majority and Minority Mean Scores on Aptitude Tests in Majority Standard Deviation Units



NOTE: C=Clerical; IF=Idea Fluency; IR=Inductive Reasoning; PF=Paper Folding; V=Vocabulary; IPH=Ideaphoria; FD-L=Finger Dexterity-Left; FD-R=Finger Dexterity-Right; G-L=Grip-Left; G-R=Grip-Right; SA=Shape Assembly; AR=Analytical Reasoning; NA=Numerical Ability; NR=Numerical Reasoning.

TABLE 9

Validity Coefficients For Total Sample

Test	Apprentice GPA	Instructor's Rating
Clerical	16*	18*
Idea Fluency	14*	09
Inductive Reasoning	29***	19**
Paper Folding	30***	25***
Vocabulary	33***	20***
Ideaphoria	02	07
FD - Left	01	02
FD - Right	07	07
Grip - Left	13*	07
Grip - Right	17*	06
Shape Assembly	26***	23***
Analytical Reasoning	31***	14*
Numerical Computation	33***	32***
Numerical Reasoning	36***	29***

NOTE: Decimal points have been omitted. N = 184; FD = Finger Dexterity.

* $p < .05$
** $p < .01$
*** $p < .001$

few cases, the tests dealing with Clerical Ability, Psychomotor Abilities (Grip and Finger Dexterity), and Idea Fluency were weakly related to the two criteria.

Table 10 presents the validity coefficients for the three carpentry specialities. For the construction sample, the basic patterns of relationships are quite similar to those found for the total sample, although the sizes of correlation coefficients are, in most instances, higher. As with total sample, the validity of aptitude tests against the instructor's rating was somewhat lower than GPA.

For the cabinet making sample, four tests--Paper Folding, Vocabulary, Numerical Computation, and Numerical Reasoning tests--were significantly related with the GPA, while the Inductive Reasoning, Paper Folding, Vocabulary, Numerical Computation, and Numerical Reasoning tests were significantly related with the rating on overall performance. This pattern of validity for cabinet making sample is relatively similar to that of the construction sample, although the sizes of the coefficients are somewnat lower and there are fewer significant coefficients. The tests which have the highest validity coefficients for the two samples are the two numerical tests, Paper Folding, and Vocabulary.

The validity pattern for the floor covering sample is generally dissimilar from the patterns found in the construction and cabinet making samples. Although most of validity coefficients against GPA are positive, only the

TABLE 10

Validity Coefficients for Carpentry Specialities

Test	Carpentry Specialities: Construction GPA	Construction IR	Cabinet Making GPA	Cabinet Making IR	Floor Covering GPA	Floor Covering IR
Clerical	09	22*	12	02	35*	26
Idea Fluency	28**	26**	08	-09	-10	-20
Inductive Reasoning	33**	26**	18	31*	43**	-19
Paper Folding	48***	45***	30*	26*	16	-20
Vocabulary	46***	30***	37**	29*	20	-10
Ideaphoria	04	19*	20	11	24	26
FD - Left	-17*	-03	14	20	-06	14
FD - Right	-17*	08	14	10	13	-13
Grip - Left	14	00	02	10	27	15
Grip - Right	12	-03	13	15	34*	16
Shape Assembly	45***	30***	16	19	19	19
Analytical Reasoning	37***	15	22	13	35	12
Numerical Computation	53***	50***	34*	35*	13	11
Numerical Reasoning	53***	43***	36**	26*	38*	12

NOTE: Decimal points have been omitted. GPA = grade point average; IR = instructor's rating; FD = Finger Dexterity. Respective N's for the construction, cabinet making, and floor covering samples are 103, 48, and 33.

* $p < .05$
** $p < .01$
*** $p < .001$

Clerical, Inductive Reasoning, Grip-Right, and Numerical Reasoning tests were significantly correlated with GPA. None of the correlations between aptitude tests and instructor's rating was statistically significant.

Table 11 presents the validity coefficients for the two ethnic groups. The pattern of coefficients is generally similar across the two groups. Significant and strong correlations occur in both groups for Paper Folding, Shape Assembly, and to a somewhat lesser extent with Inductive Reasoning and Analytical Reasoning. Some dissimilarities between groups occur on Numerical Computation, Numerical Reasoning, and Vocabulary. Vocabulary is a stronger predictor for the minority than majority group, while the reverse is the case with the two numerical tests.

Regression Analyses

This section discusses the results from multiple regression analyses (Draper & Smith, 1966; Tatsuoka, 1976) which were performed to determine the best combination of BAB tests to predict the two criterion measures, grades and instructor's ratings. The following three steps were performed in order to develop the best prediction equation.

First, a subset of the BAB tests was selected which had high validity coefficients and low inter-test correlations. That is, tests were selected which correlated highly with

TABLE 11

Validity Coefficients For Ethnic Groups

Test	Ethnic Groups			
	Majority		Minority	
	GPA	IR	GPA	IR
Clerical	15*	16*	-14	-06
Idea Fluency	05	06	28	05
Inductive Reasoning	27***	13	10	34*
Paper Folding	36***	32***	44**	47**
Vocabulary	28	13	39*	53**
Ideaphoria	02	11	26	23
FD - Left	05	10	-15	-20
FD - Right	09	13	-02	-04
Grip - Left	07	00	20	15
Grip - Right	14*	00	26	23
Shape Assembly	26***	20**	47***	58**
Analytical Reasoning	30***	12	47**	37*
Numerical Computation	39***	41***	15	12
Numerical Reasoning	39***	29**	18	27

NOTE: Decimal points have been omitted. GPA = grade point average; IR = instructor's rating; FD = Finger Dexterity. N's for the majority and minority samples are 157 and 27, respectively.

* $p < .05$
** $p < .01$
*** $p < .001$

each criterion measure and which were independent of other tests. A careful inspection of Tables 9, 10, and 11, and the test intercorrelations (see Appendix 3) revealed that six ability tests satisfied the requirements. These were: Idea Fluency, Paper Folding, Vocabulary, Shape Assembly, Numerical Computation, and Numerical Reasoning.

Second, a series of stepwise multiple regressions were performed with the selected battery of tests as predictor variables and grades and instructor's rating as criterion variables. This was done to examine single and multiple contributions of the selected battery of tests to the prediction of training performance. The results showed that four tests performed as well as the six tests. These four tests were: Paper Folding, Vocabulary, Numerical Computation, and Numerical Reasoning. The remaining two tests failed to contribute significantly to the prediction.

Finally, the selected four tests were used to predict each criterion measure for the total sample, the three carpentry specialties, and the two ethnic groups. Table 12 summarizes the results from these analyses.

Table 12 shows that the battery of four BAB tests predicts both grades and instructor's rating quite well. Multiple correlation coefficients, which measure how well the combined test is able to predict the actual or observed criterion variables, were all significant beyond .001 level. The table also indicates that the same set of four BAB tests

TABLE 12

Multiple Correlations for the Regression of Four BAB Tests on Training Performance Measures

Group	Criterion Measure	
	Grade Point Average	Instructor's Rating
Development	.48	.41
Cross-Validation	.53	.49
Construction	.60	.47
Cabinet Making	.38	.37
Floor Covering	.42	.55
Majority	.49	.44
Minority	.64	.72
Total	.41	.30

could be used for all three specialties and for minority as well as for majority group students. In other words, the four subtests were able to predict different groups about equally well.

To determine the stability of developed prediction equations the total sample was randomly divided into two groups of 123 and 61 students. Then the regression weights (prediction equation) derived from the first group, the development sample, were applied to the second group, the cross-validation sample (Tatsuoka, 1976). The results showed that the tests cross-validated well. The multiple correlations for the cross-validation sample using regression weights from the development sample were .53 for grades and .49 for instructor's rating. This indicates a good degree of stability.

Discussion

Although most of the results in this section are straight-forward, a few areas merit some discussion.

The differences between majority and minority test score means are not unexpected; they are smaller than typically found in other studies (Sung & Dawis, 1981b). The largest difference was on the Vocabulary test, which may be due to the fact that five of 26 minority students are either Hispanics or other ethnic minorities, who may not have been

completely fluent in English. Despite some mean differences, the inter-test correlation matrices presented in Appendix 3 suggest that the structure of aptitudes does not differ appreciably between ethnic groups--a finding documented elsewhere (Sung & Dawis, 1981b).

On both GPA and the rating on overall performance the means of the majority sample were approximately one standard deviation higher than the minority sample. The reasons for these differences between the two samples are obscure. Interestingly, it was found that the reliability of criteria evaluated by the correlation between the grade point average and instructor's rating on overall performance was higher for the minority sample (.551) than for the majority sample (.445). With regard to the mean difference on the GPA between specialties, lack of uniform grading policies between instructors and differences in course difficulties may account for some of these differences.

The difference in the pattern of validty coefficients between the floor covering sample and the other two samples deserves some comment. This difference may be attributable to several factors. First, the majority of floor covering sample was recruited by different procedures than the other two samples. Second, there were not as many course grades available as two other specialties, due mainly to their shorter training period. And third, turnover of instructors contributed a great deal of fluctuation to the evaluation of

student performance (the correlation between the GPA and rating on overall performance was lowest in comparison with those for the construction and mill cabinet making samples).

CHAPTER IV

Discussion

The results presented in this report indicate that four tests from the Ball Aptitude Battery--Vocabulary, Paper Folding, Numerical Computation, and Numerical Reasoning--are valid predictors of success in the Apprentice and Trainee Program at the School of Carpentry of the Washburne Trade School. The results also show that a predictor based on a composite of these four tests significantly correlate with training success. It is equally valid for both majority and minority applicants when grade point average is used as the criterion.

It must be emphasized that these tests were validated against criteria of success in the apprentice training program. No data were obtained on how scores on these predictors relate to success as a journeyman carpenter. However, given the extensiveness of on-the-job training in the Apprentice and Trainee Program, it is reasonable to assume that similar skills are required in the work of a journeyman.

The tests, of course, do not explain all of the variance associated with training success. Factors other than those measured by these tests (e.g., motivation) also contribute to training success. However, the multiple correla-

tion coefficient of .48 is considered a relatively high validity by most industrial psychologists.

Test Fairness

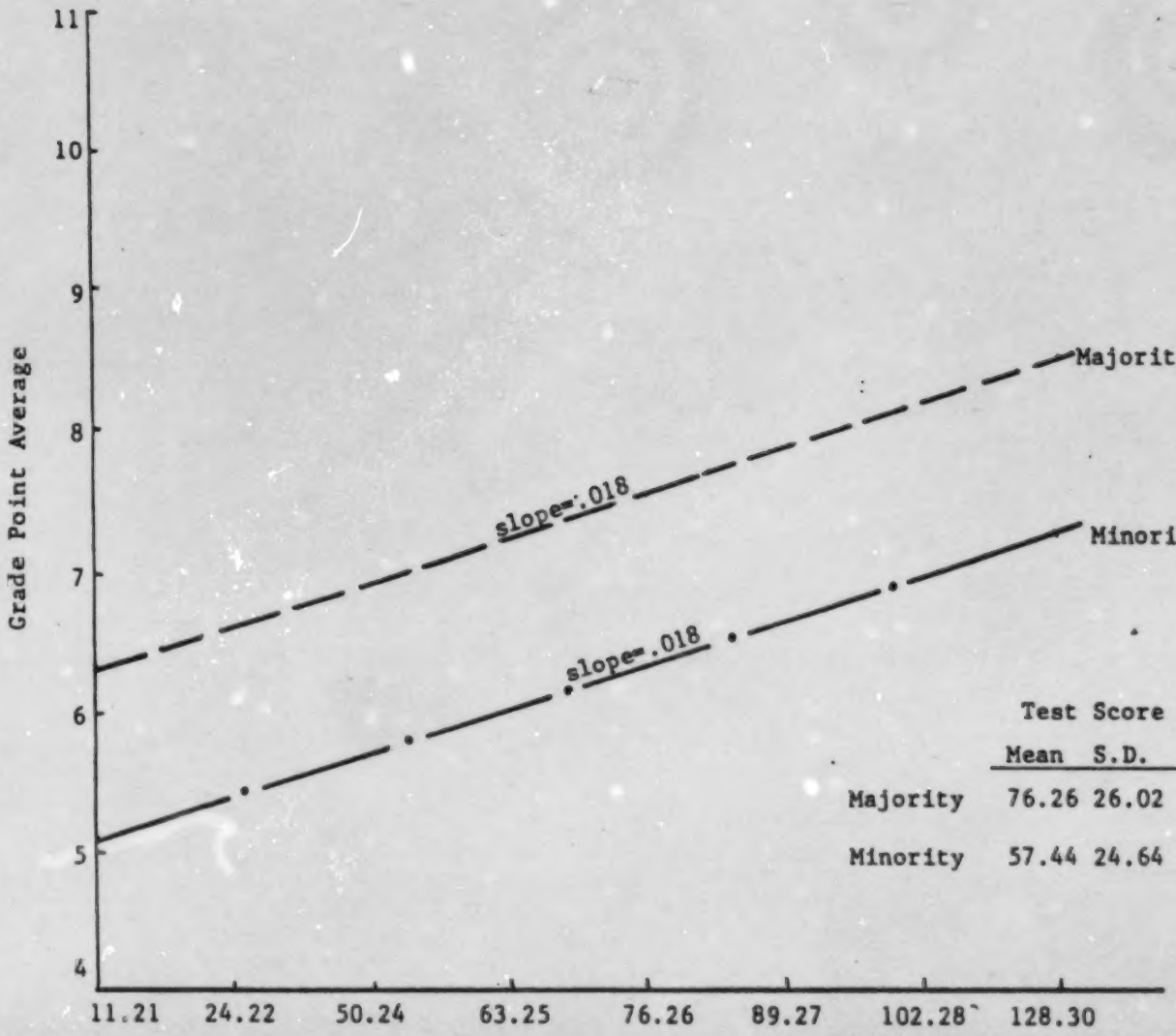
Since the results suggest that an occupational aptitude battery of four BAB tests--Paper Folding, Vocabulary, Numerical Computation, and Numerical Reasoning--would be appropriate in selecting applicants for the carpenter training programs, we now focus on several issues concerning the fairness of selection procedures using these tests to select apprentice carpenters.

The Uniform Guidelines on Employee Selection Procedures (EEOC et al., 1978) notes that "the concept of fairness or unfairness of selection procedures is a developing concept" (p. 38301). Similarly, Arvey (1979, p. 105) notes that "among psychometricians and test experts, there is no agreement on what constitutes a biased test." However, it is generally agreed that test fairness depends both on the properties of the test itself and how the test is used (Arvey, 1979; EEOC et al., 1978, p. 38301).

Test Properties. A key issue in test fairness with regard to the properties of a test is whether subgroup differences on a predictor are reflected in differences on the criterion (Arvey, 1979; EEOC et al., 1978, p. 38301).

Figure 2

Regression Lines of The Two Ethnic Groups Derived From Composite Score of the Four BAB Tests



	Test Score		GPA	
	Mean	S.D.	Mean	S.D.
Majority	76.26	26.02	7.36	1.50
Minority	57.44	24.64	5.96	1.32

Figure 2 displays the regression lines of the two ethnic groups derived from the composite score (of the Vocabulary, Paper Folding, and two numerical tests) and GPA.[2] Also, for each group the slope (beta weight), multiple correlation (R), and predictor and criterion means and standard deviations are presented. Figure 2 shows that the composite score of the four BAB tests predicts the grades of the two ethnic groups equally well. The strength of the relationship between the predictor and the criterion scores and the regression line slopes are the same for both ethnic groups, as indicated by the similar Rs and betas for each group. In other words, differences of the test by ethnic subgroup are reflected in subgroup differences on the criterion. Note that the mean predictor and criterion scores of the minority group is lower than those of the majority (i.e., differences in intercept).

This is not an unusual situation. "Regression lines generally do not differ with regard to their slopes... Regression-line difference in intercept values appears to be a relatively common phenomenon" (Arvey, 1979, p. 101).

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[2] In Appendix 4, figures which display the same type of regression lines for ethnic groups on instructor's rating and for the three carpentry specialties are given.

Test Use and Adverse Impact. Given this situation -- different group means on predictor and criterion, but equal slopes -- several alternatives are available for how the test could be used for selection. First, separate regression lines and thus different cutoff scores for each ethnic group could be used. However, if this were the case, for at any given criterion score and for its corresponding predictor scores, fewer minorities than majorities would be selected. Although this selection procedure is valid and would be fair by some definitions (Arvey, 1979), it does not consider the degree of adverse impact recommended by the EEOC Uniform Guidelines on Employee Selection Procedures, (EEOC et al., 1978). In addition, the use of different regression lines for different subgroups may lead to a situation where each regression line must be determined and validated for each and every subgroup, which is impractical.

A simpler procedure is to use a common regression line, i.e., a regression line based on the total sample, for both ethnic groups. This selection procedure would slightly underpredict the performance of the majority group and slightly overpredict the performance of the minority group.

Although adverse impact need not necessarily be considered when a test is valid, it was nevertheless studied to follow the spirit of the EEOC et al. guidelines (1978). The Uniform Guidelines on Employee Selection Procedures indicate that a selection rate for any group which is less than

four-fifths (or 80 percent) of the rate for other groups constitutes evidence of adverse impact (p. 38297). While it is clearly impossible to evaluate the precise impact on an applicant sample, Table 13 provides data regarding the potential adverse impact of three possible cutting scores (5-th percentile, 20-th percentile, and 35-th percentile) on the concurrent validity sample used in this study. While 5-th, 20-th, and 35-th percentiles might seem to be too low of a cutting score, it should be realized that the sample of apprentice carpenters included in this study has been pre-selected on another selection device. Given this situation, the raw scores associated with the 5-th and 20-th percentiles might be considered as possible scores at which candidates should be expected to be able to match the performance of current apprentices. The raw score associated with the 35-th percentile in the concurrent group might represent a cutting score higher than would be used in an actual screening context.

Table 13 indicates that for a cutting score at the 35-th percentile, the proportion of minority apprentices achieving that score or higher was less than 80 percent of majority sample passing rate; however, for cutting scores at the 20-th and 5-th percentiles the proportion of minority apprentices achieving that score or higher was over 80 percent of the proportion of majority apprentices who achieved that score. Therefore, if a composite score were used for

TABLE 13

Estimate of Adverse Impact with
Different Cutting Scores

Total Group Percentile	Raw Score	Total Sample Passing	Majority Passing	Minority Passing	Minority Selection Rate as a Percentage of Majority Selection Rate
35	59	67%	66%	37%	56%
20	45	84%	86%	74%	86%
5	23	95%	97%	86%	89%

selection and if the cutting score were set at 20-th percentile score for the total group of applicants, then the proportion of minority group members selected would be at least 80 percent of the proportion of majority group members that were selected, and all of those selected would have a grade point average of C or better and an instructor rating of slightly less than 2. Such a cutting score would meet the "four-fifths" rule and at the same time ensure that the trainees graduating from the program would be qualified.

Recommendations

Based on the results of the present study, the use of the Ball aptitude tests of Vocabulary, Paper Folding, Numerical Computation and Numerical Reasoning are recommended to assist in selecting applicants to the Chicago District Council of Carpenters Apprentice and Trainee Program. As with any selection process, test scores should be used in combination with other relevant information.

It is not the purpose of this report to determine cutting scores. The determination of cutting scores involves judgments by the organization using the tests. This report has provided information which can be useful when deciding upon cutting scores, and it is recommended that this information be considered. In particular it is suggested that the information relating cutting scores to adverse impact be

taken into consideration. A cutting score which results in no or minimal adverse impact and still results in successful applicants is perceived by many as desirable.

Future Research

After a selection program is implemented, follow up research should be periodically conducted. It is recommended that future research be conducted to periodically investigate the effectiveness of the BAB. This would be especially important if significant changes occur in the applicant pool and in the training program.

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APPENDIX 1

Apprentice Training Programs: Courses, Skills, and Related Aptitude Factors

TABLE A-1

Aptitude Factors Related to
Carpenter Apprenticeship Training:
Construction Specialty

Course Skills	Aptitude											
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Pre-Apprentice Shop													
Differentiate various hand and power tools	X	X	X	X	X	X				X		X	X
Use tools to cut, scrub, grind and drill, etc.	X	X	X	X	X	X				X		X	X
Maintain tools, Sharpening	X	X	X	X	X	X				X		X	X
Sketching	X	X	X	X	X	X				X		X	X
Pre-Apprentice Math													
Calculation	X	X	X				X	X					
Measurement	X	X	X				X	X					
Rough Framing/ Rafter													
Layout frame, construct walls, ceilings and interiors			X	X	X	X							
Blue Print Reading/ Estimating													

TABLE A-1 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Identify various part of building and shape of building		X	X	X	X	X	X	X				X	
Interpret B.P.		X	X	X	X	X	X	X				X	
Differentiate type of materials and estimate volumes of materials		X	X	X	X	X	X	X				X	
Concrete Form/ Foundation Reinforced Concrete Form													
Measures and determines location of the building			X	X	X	X	X	X					
Cut, fit and assemble pieces together following specification			X	X	X	X	X	X					
Make various forms and footings (i.e. scaffolding)			X	X	X	X	X	X					
Build forms			X	X	X	X	X	X					
Interior Finishing-Trimming													
Layout window studs, door butts, walls, floors, frame joints, etc.	X		X	X	X	X				X			
Fit and install wall molding, dry wall material,	X		X	X	X	X				X			

TABLE A-1 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
cabinets, panels, and sound proofing.													
Trim window closet, door, etc.	X		X	X	X	X				X			
Roof Framing													
Layout roof plan seat, cut, and overhang for hip, valley, rafters, ridge boards, etc.	X		X	X	X	X				X			
Calculate various lengths of rafters.	X		X	X	X	X				X			
Put different shingles.	X		X	X	X	X				X			
Install roof parts.	X		X	X	X	X				X			
Stair Building Inside/Outside													
Recognize various parts and structure of stairs.			X	X	X	X	X			X	X		
Calculate structural parts of stairs.			X	X	X	X	X			X	X		
Layout and build inside/outside stairs.			X	X	X	X	X			X	X		
Exterior Finish													
Layout set and plume exterior doors, window frames and louvres.			X	X	X	X				X	X		

TABLE A-1 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Frame and build open, closed, box cornice.			X	X	X	X				X	X		
Fit and place corner boards, wall shingles.			X	X	X	X				X	X		
Place verge, lay boards, gutters.			X	X	X	X				X	X		
Build columns, beams, etc.			X	X	X	X				X	X		
Welding/Arc Welding													
Weld metal part to structural member.		X	X	X			X	X					X
Transit Level (Survey)													
Measure the relative position of existing object.	X		X	X	X	X	X						
Layout the position of the object to be built.	X		X	X	X	X	X						
Set the elevation of project to be built.	X		X	X	X	X	X						
OSHA													
Follow codes, regulations, and safety policy.		X							X				
Inspect working situations, facilities, and all equipment.		X							X				

TABLE A-1 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Execute first aid to the injury.		X							X				
Construction Supervision													
Plan and organize works.		X			X	X			X				
Supervise working crew.		X			X	X			X				
Learn interpersonal skills and managerial ability.		X			X	X			X				
Motivate subordinates.		X			X	X			X				
Field Service Construction													
Develop unique layout, sketch, and photograph.	X		X	X	X	X			X				
Layout various framings.	X		X	X	X	X			X				
Trim interior and exterior.	X		X	X	X	X			X				
Rigging													
Splice and knot chain, rope to make various slings.			X	X						X			
Hoist and lift various materials.			X	X						X			

TABLE A-1 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Stewardship													
Learn about labor history,		X							X				

NOTE: P=Perceptual Speed of Accuracy; V=Verbal Comprehension; S-1=Spatial I (paper); S-2=Spatial II (shape); I=Inductive Reasoning; A=Analytical/Synthetic; NC=Numerical Computation; NR=Numerical Reasoning; IF=Idea Fluency; FD=Finger Dexterity; G=Grip; M=Memory; MC=Mechanical.

TABLE A-2

Aptitude Factors Related to
Carpenter Apprenticeship Training:
Cabinet Making Specialty

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Shop I													
Differentiate the use of various hand and power tools.		X		X	X	X				X		X	X
Use tools to cut, sand, fasten, and drill.		X		X	X	X				X		X	X
Maintain tools (sharpening and lubricating).		X		X	X	X				X		X	X
Math													
Calculation.	X	X	X				X	X					
Measurement.	X	X	X				X	X					
Blue Print Reading													
Identify the shapes and various parts of the project to be built from architects drawing.		X	X	X	X	X	X	X				X	
Determine types, size, and volume of materials from drawing.		X	X	X	X	X	X	X				X	

TABLE A-2 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Shop II													
Layout frames for doors, windows, cases, panels, etc.	X	X	X		X	X				X	X		X
Plans sequences of cutting or shaping and assembling parts.	X	X	X		X	X				X	X		X
Sets machines to cut and shape parts from woodstock.	X	X	X		X	X				X	X		X
Cut pieces to finish sizes.	X	X	X		X	X				X	X		X
Sand or trim pieces to insure a snug fit.	X	X	X		X	X				X	X		X
Assemble pieces by glue, nails, screws, etc.	X	X	X		X	X				X	X		X

NOTE: P=Perceptual Speed of Accuracy; V=Verbal Comprehension; S-1=Spatial I (paper); S-2=Spatial II (shape); I=Inductive Reasoning; A=Analytical/Synthetic; NC=Numerical Computation; NR=Numerical Reasoning; IF=Idea Fluency; FD=Finger Dexterity; G=Grip; M=Memory; MC=Mechanical.

TABLE A-3

Aptitude Factors Related to
Carpenter Apprenticeship Training:
Floor Covering Specialty

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Shop I													
Differentiate the various uses of hand and power tools.		X		X	X	X				X		X	X
Use tools to cut, sand, scrape, fit and seam with putty.		X		X	X	X				X		X	X
Maintains tools.		X		X	X	X				X		X	X
Layout plans.		X		X	X	X				X		X	X
Math													
Measurement.	X	X	X				X	X					
Calculation.	X	X	X				X	X					
Blue Print Reading Sketching													
Identify the shapes and various parts of project to be installed.		X	X	X	X	X	X	X				X	
Determine type, size, and volume of materials to be used.		X	X	X	X	X	X	X				X	

TABLE A-3 (Cont.)

Course Skills	Aptitude												
	P	V	S-1	S-2	I	A	NC	NR	IF	FD	G	M	MC
Shop II													
Layouts and measures plans.	X		X	X			X			X			
Prepares surface by sanding, patching, scraping, and priming.	X		X	X			X			X			
Measures and cuts covering materials with tools.	X		X	X			X			X			
Fix materials on surface by glueing, nailing, and taping.	X		X	X			X			X			
Cut or trim and seam. Sew the carpet edge.	X		X	X			X			X			

NOTE: P=Perceptual Speed of Accuracy; V=Verbal Comprehension; S-1=Spatial I (paper); S-2=Spatial II (shape); I=Inductive Reasoning; A=Analytical/Synthetic; NC=Numerical Computation; NR=Numerical Reasoning; IF=Idea Fluency; FD=Finger Dexterity; G=Grip; M=Memory; MC=Mechanical.

APPENDIX 2

Job Descriptions of Three
Specialities from the
Dictionary of Occupational Skills

CARPENTER (const.)

860.381-022

Constructs, erects, installs, and repairs structures and fixtures of wood, plywood, and wallboard, using carpenter's handtools and power tools, and conforming to local building codes: Studies blueprints, sketches, or building plans for information pertaining to type of material required, such as lumber or fiberboard, and dimensions of structure or fixture to be fabricated. Selects specified type of lumber or other materials. Prepares layout, using rule, framing square, and calipers. Marks cutting and assembly lines on materials, using pencil, chalk, and marking gage. Shapes materials to prescribed measurements, using saws, chisels, and planes. Assembles cut and shaped materials and fastens them together with nails, dowel pins, or glue. Verifies trueness of structure with plumb bob and carpenter's level. Erects framework for structures and lays subflooring. Builds stairs and lays out and installs partitions and cabinet work. Covers subfloor with building paper to keep out moisture and lays hardwood, parquet, and wood-strip-block floors by nailing floors to subfloor or cementing them to mastic or asphalt base. Applies shock-absorbing, sound deadening, and decorative paneling to ceilings and walls. Fits and installs prefabricated window frames, doors, door frames, weather stripping, interior and exterior trim, and finish hardware, such as locks, letterdrops, and kick

plates. Constructs forms and chutes for pouring concrete. Erects scaffolding and ladders for assembling structures above ground level. May weld metal parts to steel structural members. When specializing in particular phase of carpentry is designated according to specialty as COMBINATION-WINDOW INSTALLER (const.); LAY-OUT CARPENTER (const.). When specializing in finish carpentry, such as installing interior and exterior trim, building stairs, and laying hardwood floors is designated FINISH CARPENTER (const.). When erecting frame buildings and performing general carpentry work in residential construction is designated HOUSE CARPENTER (const.). May remove and replace sections of structures prior to and after installation of insulating materials and be designated BUILDING-INSULATING CARPENTER (const.,; ret. tr.). May perform carpentry work in construction of walk-in freezers and environmental test chambers and be designated CARPENTER, REFRIGERATOR (refrigerat. equip.). Additional titles: DOOR HANGER (const.); FINISHED-HARDWARE ERECTOR (const.); GARAGE-DOOR HANGER (const.); HARDWOOD-FLOOR INSTALLER (const.); JALOUISE INSTALLER (const.); STAIR BUILDER (const.); TRIM SETTER (const.); WEATHER STRIPPER (const.); WOOD-SASH-AND-FRAME CARPENTER (const.); WOOD-STRIP-BLOCK FLOOR INSTALLER (const.).

CARPENTER APPRENTICE (const.)

860.381-026

Performs duties as described under APPRENTICE (any ind.).

CABINETMAKER

660.280-010

Sets up and operates variety of woodworking machines and uses various handtools to fabricate and repair wooden cabinets and high grade furniture: Studies blueprints or drawings of articles to be constructed or repaired, and plans sequence of cutting or shaping operations to be performed. Marks outline or dimensions of parts on paper or lumber stock, according to blueprint or drawing specifications. Matches materials for color, grain, or texture. Sets up and operates woodworking machines, such as power saws, jointer, mortiser, tenoner, molder, and shaper, to cut and shape parts from woodstock. Trims component parts of joints to insure snug fit, using handtools, such as planes, chisels, or wood files. Bores holes for insertion of screws or dowels by hand or using boring machine. Glues, fits, and clamps parts and subassemblies together to form complete unit, using clamps or clamping machine. Drives nails or other fasteners into joints at designated places to reinforce joints. Sands and scrapes surfaces and joints of articles to prepare articles for finishing. May repair high-grade articles of furniture. May dip, brush, or spray assembled articles with protective or decorative materials, such as stain, varnish, or paint. May install hardware, such as hinges, catches, and drawer pulls. May repair furniture, equipment, and fixtures and be designated as

CABINETMAKER, MAINTENANCE (woodworking). May be designated according to products made as PIANO-CASE MAKER (musical inst.). May cut, shape, and assemble wooden parts to construct frames for refrigeration equipment and be designated as REFRIGERATOR CABINETMAKER (refrigerat. equip.).

CABINETMAKER APPRENTICE

660.280-014

Performs duties as described under APPRENTICE (any ind.).

CARPET LAYER (ret. tr.)

864.381-010

Lays carpet and rugs: Measures and cuts carpeting to size according to floor sketches, using the carpet knife. Sews sections of carpeting together by hand. Cuts and trims carpet to fit along wall edges, openings, and projections. May lay linoleum.

FLOOR LAYER (const.; ret. tr.)

floor coverer; floor covering-tile layer

864.481-010

Applies blocks, strips, or sheets of shock-absorbing, sound-deadening, or decorative covering to floors, walls and cabinets: Disconnects and removes obstacles, such as appliances and light fixtures. Sweeps, scrapes, sands, or chips dirt and irregularities form base surfaces, and fills cracks with putty, plaster, or cement grout to form smooth, clean foundation. Measures and cuts covering material, such as felt, according to blueprints and sketches, using rule, straightedge, linoleum knife, and snips. Spreads adhesive cement over floor to cement foundation material to floor board joints. Lays out centerlines, guidelines, and borderlines on foundation with chalkline and dividers. Spreads

cement on foundation materials with serrated knife. Lays covering on cement, following guidelines, to keep tile courses straight and butt edges of blocks to match patterns and execute designs. Joins sections of sheet covering by overlapping adjoining edges and cutting through both layers with knife to form tight joint. Rolls finished floor to smooth it and press cement into base and covering. May soften area of floor covering with butane torch to fit materials around irregular surfaces. May lay carpet (CARPET LAYER (ret. tr.)). May be designated according to type of floor laid as ASPHALT-TILE-FLOOR LAYER (const.; ret. tr.); CORK-TILE-FLOOR LAYER (const.; ret. tr.); LINOLIEUM-FLOOR LAYER (const.; ret. tr.); RUBBER-TILE-FLOOR LAYER (const.; ret. tr.).

FLOOR-LAYER APPRENTICE (const.; ret. tr.)

floor-covering apprentice.

864.481-014

Performs duties as described under APPRENTICE (any ind.).

APPENDIX 3

BAB Test Intercorrelations for
Majority and Minority Groups

TABLE A-4

BAB Test Intercorrelations for Majority (Upper Triangle) and Minority (Lower Triangle) Groups

Test Name	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1. Clerical	--	10	17	-02	38	01	15	17	12	27	-04	-04	-15	13	28	26
2. Idea F.	39	--	03	-18	29	13	21	45	30	17	-07	-07	12	16	15	08
3. Induct. R.	02	14	--	03	07	39	36	-07	-05	02	09	07	31	36	26	34
4. Word A.	13	-04	06	--	14	-07	-11	-03	-01	-11	-04	-02	-06	-02	-03	-06
5. Writing S.	52	45	-01	05	--	-03	18	27	35	34	-18	-10	-10	16	22	10
6. Paper F.	-23	27	34	-02	00	--	37	10	-11	-01	00	04	49	41	46	49
7. Vocabulary	15	35	30	11	01	42	--	07	-08	-05	-11	-04	19	48	50	48
8. Ideaphoria	33	38	10	-15	24	-09	46	--	30	25	-20	-14	-04	03	20	11
9. FD-L	10	00	13	20	28	-06	-31	-13	--	58	-05	-10	-06	09	-04	-12
10. FD-R	34	07	31	09	33	-02	-22	00	81	--	-10	-03	-11	03	02	-03
11. Grip-L	-16	-15	10	-38	-34	05	23	-20	-09	-17	--	73	-01	-02	-03	02
12. Grip-R	-18	-22	-12	-23	-34	-07	19	-17	-13	-27	84	--	07	-02	06	02
13. Shape A.	-41	-03	28	06	-43	47	31	-07	-03	-04	37	40	--	31	29	30
14. Analyt. R.	-06	21	28	-15	-18	61	59	-04	-21	-09	40	34	41	--	36	46
15. Num. I	22	15	01	22	16	36	50	07	-32	-19	01	05	-05	36	--	72
16. Num. II	16	46	21	31	08	52	69	24	-42	-29	-09	-06	10	46	72	--

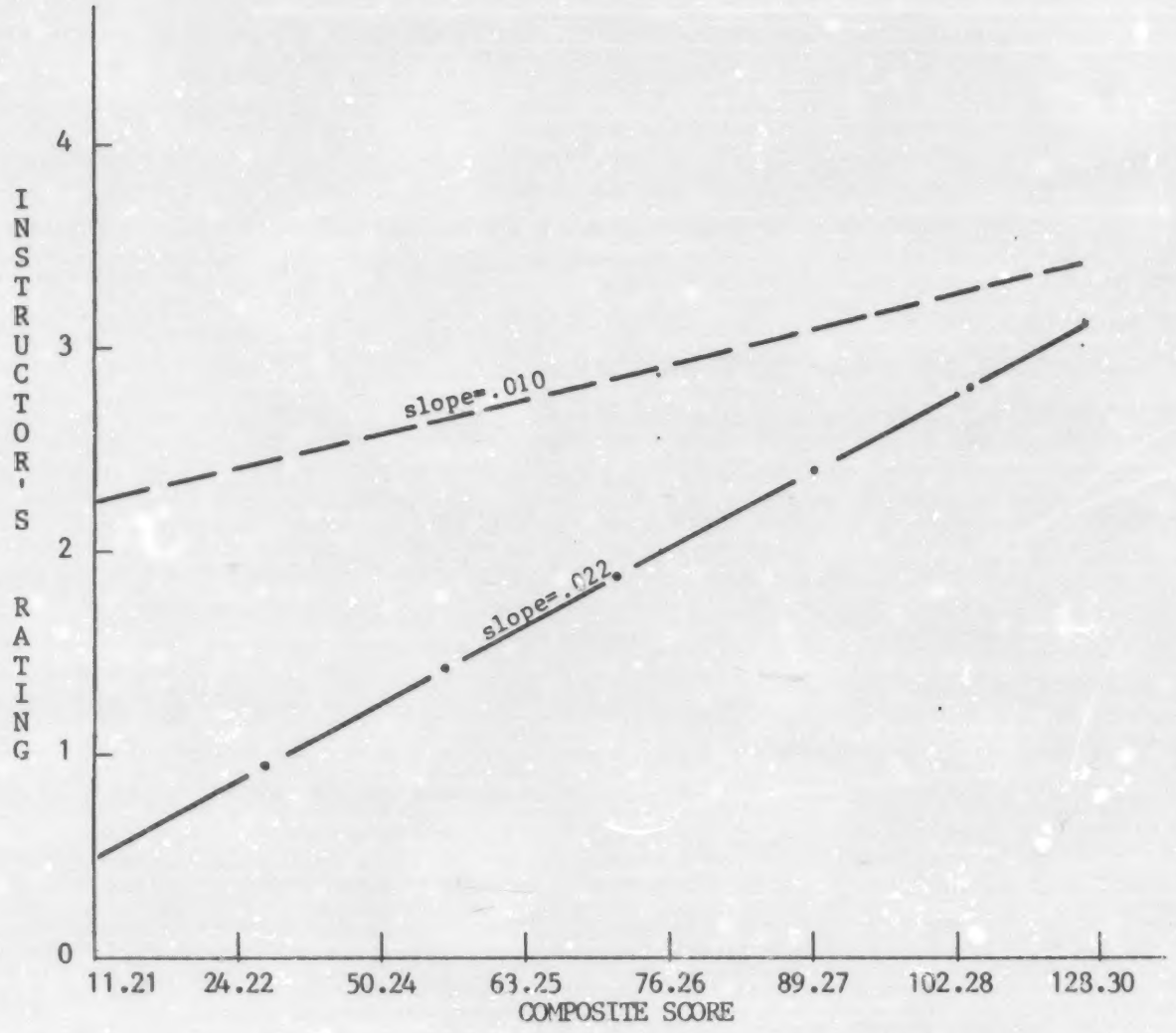
NOTE: Decimal points are omitted. Majority N = 157 and Minority N = 27.

APPENDIX 4

Regression Lines by Ethnic Group
Test Scores and Instructor's Rating
and by Speciality Group Score
and GPA and Instructor's Rating

Figure A-1

Regression Lines of The Two Ethnic Groups Derived From Composite Score of the Four BAB Tests



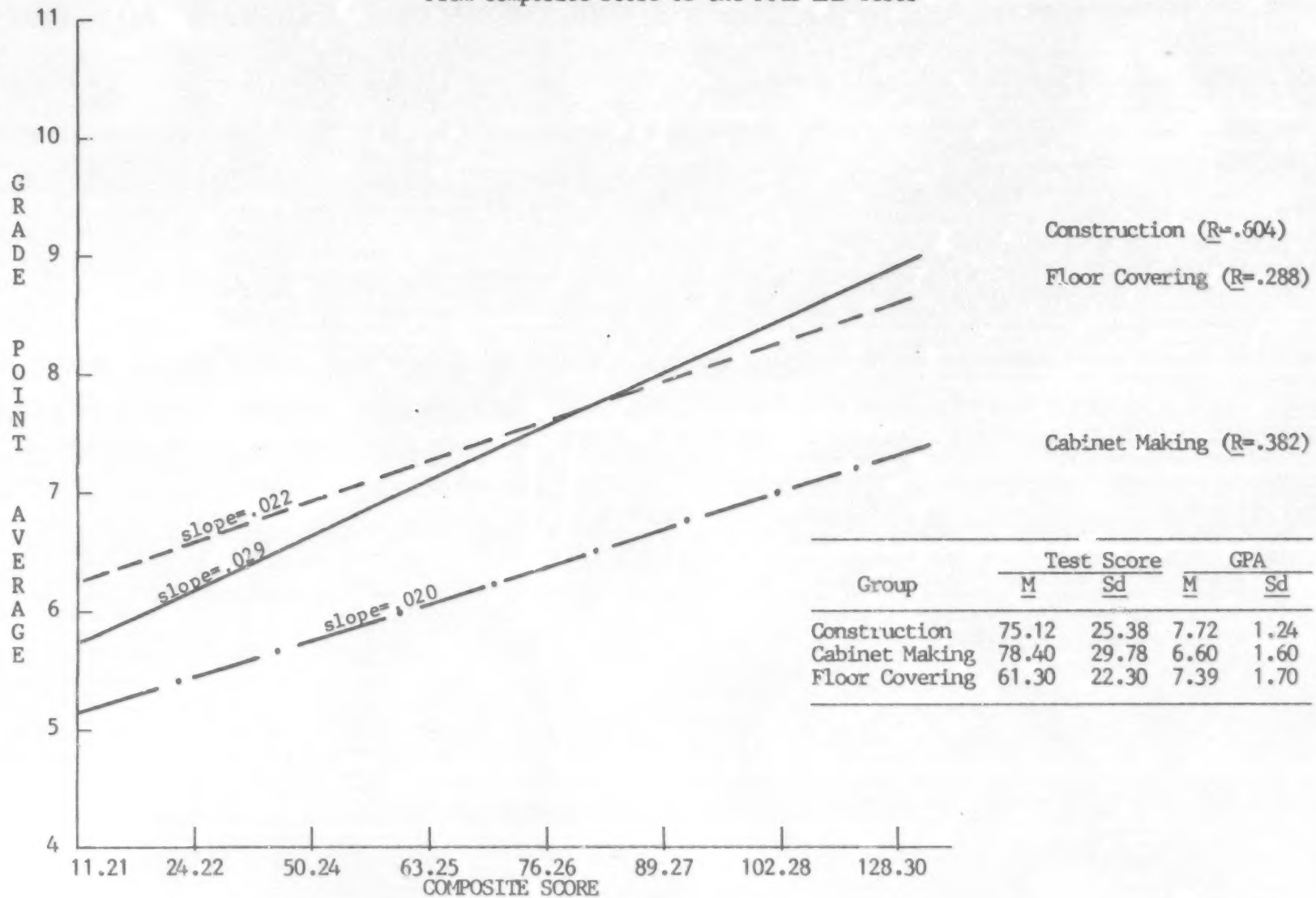
Majority (R=.222)

Minority (R=.467)

	Instructor's Rating	
Group	M	Sd
Majority	2.82	1.12
Minority	1.66	1.16

Figure A-2

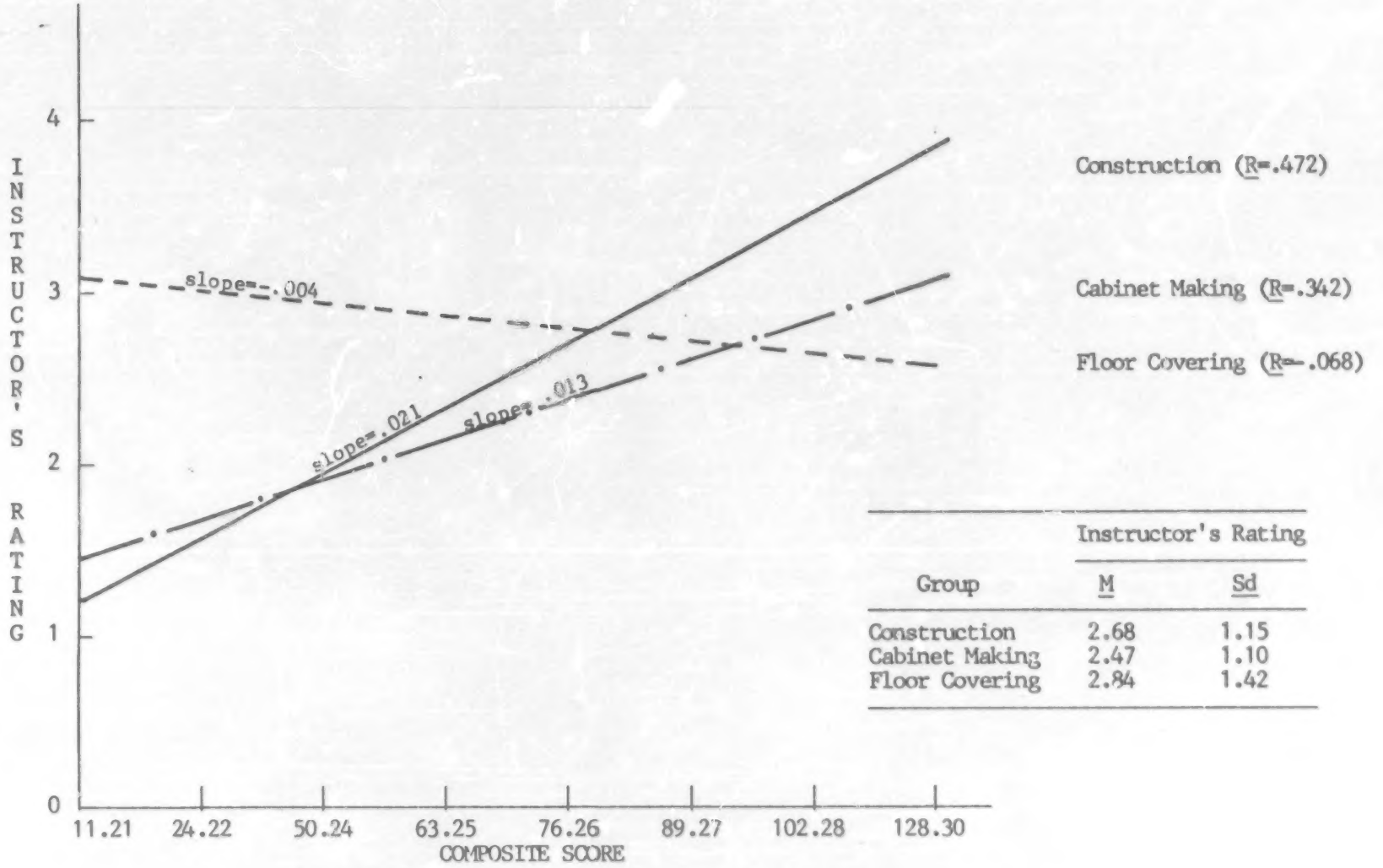
Regression Lines of Three Carpentry Specialties Derived From Composite Score of the Four BAB Tests



Group	Test Score M	Test Score Sd	GPA M	GPA Sd
Construction	75.12	25.38	7.72	1.24
Cabinet Making	78.40	29.78	6.60	1.60
Floor Covering	61.30	22.30	7.39	1.70

Figure A-3

Regression Lines of Three Carpentry Specialties Derived From Composite Score of the Four BAB Tests



Group	Instructor's Rating	
	M	Sd
Construction	2.68	1.15
Cabinet Making	2.47	1.10
Floor Covering	2.84	1.42